MULTIMEDIA UNIVERSITY

STUDENT ID NO

MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 3, 2021/2022

DEM5038 – ENGINEERING MATHEMATICS 3

(Diploma in Electronics Engineering)

9 AUGUST 2022
9.00 a.m. – 11.00 a.m.
(2 Hours)

INSTRUCTIONS TO STUDENT

1. This question paper consists of **5** pages excluding the cover page.
2. Answer **ALL** questions. All necessary working steps must be shown.
3. Write all your answers in the answer booklet provided.
4. Statistical book is provided.

Please answer ALL questions and show the necessary working. Total mark is equal to 100.

Question 1 (25 marks)

a) Find the solution to the homogeneous differential equation:

$y''+8y'+16y=0 \quad y(0)=0; \quad y'(0)=2$ [9 marks]

b) Find the solution to the following non-homogenous differential equation:

$y''-2y=\cos 2x$ [16 marks]

Question 2 (25 marks)

a) Find the Fourier series for $f(x)=\begin{cases}0, & -\pi<x<0\\ 3, & 0<x<\pi\end{cases}; \quad f(x+2\pi)=f(x)$

[11 marks]

b) Given one period of a periodic function as $f(x)=\begin{cases}-x, & -\pi<x<0\\ x, & 0<x<\pi\end{cases}$

Find the half-range cosine series for the above function. [14 marks]

Continued...

Question 3 (25 marks)

a) Determine the Laplace transform of the following functions.

i. $2t^2 - 3$ [2 marks]

ii. $e^{2t}\cosh 3t - te^{2t}$ [2 marks]

iii. $\int_0^t \cos 3t \, dt$ [2 marks]

iv. $u(t-5)$ [2 marks]

b) Find the inverse Laplace transform for the following functions.

i. $\frac{1}{s-2} + \frac{4}{s+3}$ [2 marks]

ii. $\frac{s+3}{(s+3)^2 - 16}$ [2 marks]

c) Find the solution to the following differential equation by using Laplace transform method.

$y''+2y'=e^{2t} \qquad y(0)=0,\ y'(0)=1$ [13 marks]

Continued...

Question 4 (25 marks)

a) In an XYZ bank, past data shows that 7% of all credit card holders has experienced card default at some time in their lives. Last week, this bank has issued 12 credit cards to 12 new customers. Find the probability that of these 12 customers,

i. Exactly 3 will face default of credit cards. [2 marks]

ii. More than 5 will face default of credit cards. [2 marks]

iii. Less than 2 will face default of credit cards. [2 marks]

b) In year 1993, the average consumption of red meat per person in the United States was 111.9 pounds. In a recent survey taken on a sample of 100 people revealed that they consumed on average 106.5 pounds of red meat with a standard deviation of 26.5 pounds. Test at 5% significance level if the average consumption of red meat per person is now different than 111.9 pounds.

[7 marks]

c) Table 1 provides data on seven salesman working experience (in years) and the number of computers sold during the last three months by the salesman:

Table 1

Experience (x)	**Computers sold (y)**
4	19
12	42
9	28
6	33
10	39
16	35
7	23

i. Find the estimate regression line of y on x, $\hat{y} = a + bx$. [10 marks]

ii. Estimate the number of computers the salesman is able to sell if he has 11 years of working experience. [2 marks]

End of Page.

Appendix

Quadratic formula $m = \dfrac{-b \pm \sqrt{b^2 - 4ac}}{2a}$

Annihilator for special functions

Annihilator	
D^n	$1, x, x^2, x^3, x^4, \ldots\ldots, x^{n-1}$
$(D-a)^n$	$e^{ax}, xe^{ax}, x^2e^{ax}, x^3e^{ax}, x^4e^{ax}, \ldots\ldots, x^{n-1}e^{ax}$
$\left(D^2 - 2aD + (a^2+b^2)\right)^n$	$e^{ax}\cos bx, xe^{ax}\cos bx, x^2e^{ax}\cos bx, x^3e^{ax}\cos bx, \ldots\ldots, x^{n-1}e^{ax}\cos bx$ and $e^{ax}\sin bx, xe^{ax}\sin bx, x^2e^{ax}\sin bx, x^3e^{ax}\sin bx, \ldots\ldots, x^{n-1}e^{ax}\sin bx$

Fourier Series

$$F(x) = a_0 + \sum_{n=1}^{\infty}\left(a_n \cos\frac{n\pi}{L}x + b_n \sin\frac{n\pi}{L}x\right)$$

$$a_0 = \frac{1}{2L}\int_{-L}^{L} f(x)dx$$

$$a_n = \frac{1}{L}\int_{-L}^{L} f(x)\cos\frac{n\pi}{L}xdx$$

$$b_n = \frac{1}{L}\int_{-L}^{L} f(x)\sin\frac{n\pi}{L}xdx$$

Integration Formula

$$\int \sin axdx = -\frac{1}{a}\cos ax$$

$$\int \cos axdx = \frac{1}{a}\sin ax$$

$$\int x\sin axdx = \frac{1}{a^2}(\sin ax - ax\cos ax)$$

$$\int x\cos axdx = \frac{1}{a^2}(\cos ax + ax\sin ax)$$

$$\int x^2\sin axdx = \frac{1}{a^3}(2ax\sin ax + 2\cos ax - a^2x^2\cos ax)$$

$$\int x^2\cos axdx = \frac{1}{a^3}(2ax\cos ax - 2\sin ax + a^2x^2\sin ax)$$

Linear Regression and Correlation

$$\hat{y} = a + bx$$

$$SS_{xy} = \sum xy - \frac{(\sum x)(\sum y)}{n} \qquad SS_{xx} = \sum x^2 - \frac{(\sum x)^2}{n} \qquad SS_{yy} = \sum y^2 - \frac{(\sum y)^2}{n}$$

$$b = \frac{SS_{xy}}{SS_{xx}} \qquad a = \bar{y} - b\bar{x} = \frac{\sum y}{n} - b\frac{\sum x}{n}$$

$$r = \frac{SS_{xy}}{\sqrt{SS_{xx}SS_{yy}}}$$

Transformation of some functions

$f(t)$	$L\{f(t)\}$
1	$\frac{1}{s}$, s>0
t	$\frac{1}{s^2}$
t^n	$\frac{n!}{s^{n+1}}$ $n = 1,2,3,\ldots$
e^{at}	$\frac{1}{s-a}$, s>a
$t\,e^{at}$	$\frac{1}{(s-a)^2}$
y'	$sY(s)-y(0)$
y''	$s^2Y(s)-sy(0)-y'(0)$

$f(t)$	$L\{f(t)\}$
$\sin \omega t$	$\frac{\omega}{s^2+\omega^2}$
$\cos \omega t$	$\frac{s}{s^2+\omega^2}$
$\sinh \omega t$	$\frac{\omega}{s^2-\omega^2}$
$\cosh \omega t$	$\frac{s}{s^2-\omega^2}$
$(1)u(t-a)$	$\frac{e^{-sa}}{s}$
$(t-a)u(t-a)$	$\frac{e^{-sa}}{s^2}$

Second Shift Theorem

$$L\{f(t-a)u(t-a)\} = e^{-as}L\{f(t)\}$$
$$L\{f(t)u(t-a)\} = e^{-as}L\{f(t+a)\}$$

Binomial Probabilities $\binom{n}{x}p^x q^{n-x}$

Binomial Formulae when using Cambridge Statistical Table

Key Formulas (if $p \le 0.5$)

1. $P(X=r) = B(r) - B(r-1)$
2. $P(X \ge r) = 1 - B(r-1)$
3. $P(X > r) = 1 - B(r)$
4. $P(a \le X \le b) = B(b) - B(a-1)$
5. $P(X \le r) = B(r)$

Key Formulas (if $p > 0.5$)

1. $P(X=r) = P(Y=n-r) = B(n-r) - B(n-r-1)$
2. $P(X \ge r) = P(Y \le n-r) = B(n-r)$
3. $P(X \le r) = P(Y \ge n-r) = 1 - B(n-r-1)$
4. $P(a \le X \le b) = P(n-b \le Y \le n-a)$
   $= B(n-a) - B(n-b-1)$

Normal Distribution $Z = \frac{X-\mu}{\sigma}$

Hypothesis Testing $S_x = \frac{s}{\sqrt{n}}$ $Z = \frac{\bar{x}-\mu}{S_x}$